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NOTES REGARDING JUNIOR HIGH SCHOOL MATHEMATICS PROGRAMS

INCLUDING

PROGRAM OF STUDIES

1974

DEPARTMENT OF EDUCATION

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RATIONALE OF THE JUNIOR HIGH SCHOOL MATHEMATICS PROGRAM

B. S. Bloom states that "most students (perhaps over 90 per cent) can master what we have to teach them, and it is the task of instruction to find the means which will enable students to master the subject under consideration."¹

In a sense, the rationale for the development and provision of a single core program in junior high school is related to the statement in that we assume, with reasonable certainty, that the greater majority of our students have the right to pursue a common program which is relatively academic in nature, and also that this program is attainable by them. This decision is based on the provision that successful attainment within the program by all students is possible, but that this is dependent on a reasonable factor of flexibility given to schools and teachers, not in concepts to be taken, but rather in the degree of complexity of concept development that may be expected of each individual student.

During the period of junior high school, students have not reached a level of maturity by which decisions affecting their future can justifiably be made by the individual student. Also development in intellectual ability which may be used to promote a "streaming or grouping" of students to special programs cannot be realistically and accurately determined. Therefore, a realistic, common program should be available to all to pursue, which will also provide for social and emotional development in a regular social environment. For students intellectually and specially endowed, special provisions are available for extension in the area of options.

Finally, and without additional comment, one might consider the value of mathematics that is often overlooked from the following.

One of the most important aspects in dealing with mathematics is that patterns of mathematical thinking are much the same as the fundamental patterns of all thinking. As a result mathematical learning assumes great importance.

Mathematics is an invention of the human mind--a creative venture--and thus susceptible to change and revision. In this light students can be led to their own creations. Mathematics is not just about number and space; it can be said to happen when the mind classifies and creates structures. Although it is a complex activity, students can work happily in this complexity. It also incorporates the development of attitudes--attitudes that provide a stimulus and meaning to the learning environment.

1. Bloom, B. S., "Learning for Mastery," article in UCLA Evaluation Comment, May, 1968, Vol. 1, No. 2.

PHILOSOPHY OF THE JUNIOR HIGH SCHOOL MATHEMATICS PROGRAM

In developing the junior high school mathematics program, the committee proceeded on the basis of the following guidelines:

1. THE COURSE OUTLINES FOUND IN THE JUNIOR HIGH SCHOOL PROGRAM OF STUDIES INDICATE THE TOPICS WHICH SHOULD BE COVERED OVER A THREE-YEAR PERIOD OF JUNIOR HIGH SCHOOL.
2. The sequence of topics listed in the course outlines need not be followed. In fact, the use of some of the recommended texts will suggest considerable changes in the sequence. It is considered very desirable that students should treat all the topics in some manner during the junior high school period.
3. The textbooks recommended provide a variety of approaches and varying depths of treatment of specific topics. Teachers may find it very desirable to use different sources for presenting some topics, for practice material or as sources of supplementary or enrichment materials.

It is suggested that teachers may find the teacher's editions valuable sources of information regarding:

- a) material that might be omitted for slow learners
 - b) material that might be added for high ability students
 - c) methods of presentation
 - d) reference materials
 - e) sources of manipulative materials.
4. The amount of time that might be spent on a specific topic must be decided by the teacher and will vary according to the needs and abilities of the class. If coverage in depth of a number of topics requires a substantial amount of time and therefore necessitates a substantial amount of homework by students, teachers should strongly consider reducing the depth of coverage of some of the topics.
 5. An over-riding consideration on the part of teachers relative to the manner in which the course is treated should be the degree to which students are experiencing a feeling of success with the program involved. The purpose of identifying the junior high school mathematics program in the manner that has been carried forward is to provide teachers with the opportunity to achieve this objective. No particular text should be looked upon as the program of studies. Teachers who look upon a particular text as a program of studies will have difficulty completing the program in the time that is devoted to mathematics in a given grade.

PROGRAM OF STUDIES

Objectives

The objectives for junior high school mathematics courses are:

1. To develop an understanding of mathematical concepts and an appreciation of mathematical structure.
2. To develop skill in the use of the fundamental processes.
3. To develop systematic methods of analyzing problems and of presenting their solutions.
4. To develop habits of precise thought and expression.
5. To develop an understanding of the significance and application of mathematics in the modern world.

Junior High School Mathematics Course Outlines

The list of topics indicates the program of studies in junior high school mathematics. While the list has been distributed through three years of study, it is not necessary to follow the yearly sequence of topics indicated. If departures from the sequence are made, coordination in the school should ensure that the complete program has been offered by the end of the junior high period.

GRADE VII MATHEMATICS

Recommended Texts

Hanwell, et al. CONTEMPORARY MATHEMATICS 1

Keedy et al. EXPLORING MODERN MATHEMATICS, Book 1

Van Engen, et al. MATHEMATICS CONCEPTS AND APPLICATIONS, First Course

Topics

A. Sets

1. An understanding of the concepts of set and subset
2. The ability to make appropriate use of set notation
3. Knowledge of and ability to perform the operations of union and intersection.

B. The Whole Number System

1. The position of whole numbers on the number line
2. Ability to perform operations on the whole numbers
3. Recognition and identification of the following properties of operations on the whole number system.
 - a) closure
 - b) commutative
 - c) associative
 - d) distributive
4. The properties of the identity elements
5. Conventions for the order of operations in simplification of expressions
6. Operations with number sentences containing variables--equalities and inequalities
7. Use of number sentences to solve problems.

C. Factors and Multiples

1. Understanding and application of the terms "factor" and "multiple"
2. Identification of prime and composite numbers, and use of these characteristics
3. Prime factorization of composite numbers
4. Identification of common factors and common multiples of composite numbers
5. Calculation of GCF and LCM of numbers.

D. Fractional Numbers

1. Understanding fractional or rational numbers of arithmetic
2. The position and order of fractional numbers on the number line
3. The ability to perform operations accurately on fractional numbers
4. Recognition and identification of properties of operations on the fractional number system
5. Decimal numeral representation of fractional numbers, and the expansion of the decimal numeration system.
6. Computations using decimal numerals
7. Transformation of fractional numbers into decimal numeral form; repeating and terminating decimals
8. Simplification of expressions and the solution of problems involving fractions.

E. Rates, Ratio and Percent

1. Development of the concepts, common and unique properties of ratio and rate
2. The meaning of percent
3. Transformation of percent into decimal and fractional equivalents
4. Solution of problems using and involving rates, ratio and percent.

F. Geometry

1. Development of the ability to recognize and identify the following elements of plane geometry, and extending knowledge of the interrelationships of these elements: point, line, plane, segment, ray, curve, closed curve, angle, triangle, other simple polygons, circle, interior and exterior regions.

GRADE VIII MATHEMATICS

Recommended Texts

Hanwell et al. CONTEMPORARY MATHEMATICS 2

Keedy et al. EXPLORING MODERN MATHEMATICS, Book 2

Van Engen, et al. MATHEMATICS CONCEPTS AND APPLICATIONS, Second Course.

Topics

A. Rational Numbers

1. An examination of integers as a subset of the rational numbers
2. The position and order of integers on the number line
3. Extending computational facility and understanding of the operations on integers
4. Extending knowledge of closure, associative, commutative, distributive, and identity properties of operations on integers
5. Extending the number system to positive and negative rational numbers
6. The position and order of the extended system on the number line
7. Operations $+ - \times \div$ in the rational number system
8. Number system properties in the rational number system
9. Investigation and understanding of the properties of zero
10. Reinforcement of computational skills with fractional numbers including decimal numerals
11. Development of the concept, notation and computational skills of exponents and related properties:
 - a) positive, negative, and zero integral powers
 - b) use of exponential notation in multiplication and division.

B. Conditions or Equations

1. Use of conditions or equations in the solutions of problems involving equalities and inequalities.
2. Use of graphs to determine the solutions to conditions or equations
3. The solution of problems involving conditions or equations

C. Geometry

1. The measure and comparison of segments using British and metric units
2. Measurement of angles
3. Categorization of the types of angles formed by the intersection of coplanar lines
4. The triangle, including classifications, similarity, perimeters, areas, and the unique property of the sum of the interior angles
5. The quadrilaterals, including classifications, perimeters and areas
6. Classification of polygons
7. Simple geometric constructions: bisectors of angles and segments, construction of parallels and perpendiculars, and construction of simple polygons
8. The circumference and area of circles
9. Applications of geometry to the solution of problems.

D. One of the following three topics:

Introduction to Real Numbers

1. Extension of the number system to include irrational numbers
2. Properties of the operations on the real numbers: closure, commutative, etc.
3. Additional properties of the number system: order, completeness, density
4. An introduction to graphing on the real plane
5. Solution of problems involving conditions or equations with real numbers

OR

Introduction to Polynomials in One Variable

1. Introduction to polynomials
2. Addition, subtraction and multiplication of polynomials

OR

Extension of Geometry

1. The characteristics of congruent and similar triangles
2. The Pythagorean Theorem and its applications
3. Categorization, surface areas and volumes of prisms, cylinders, cones, pyramids and spheres
4. Solution of practical problems in geometry.

GRADE IX MATHEMATICS

Recommended Texts

Hanwell et al. CONTEMPORARY MATHEMATICS 3

Keedy et al. EXPLORING MODERN MATHEMATICS, Book 3

Devlin et al. ELEMENTARY ALGEBRA

Armour, GEOMETRY SUPPLEMENT

Note: The specific topics remaining for presentation in the third year of junior high school will depend upon the option elected for Unit D in the Grade VIII year. Those options not taught in Grade VIII should be included in the Grade IX program.

Topics**A. Extension of Real Numbers**

1. Introduction to real numbers (see Grade VIII program, Section D-1)
2. Calculating and graphing solutions to problems involving conditions or equations
3. Solution of problems involving real numbers.

B. Extension of Polynomials

1. Introduction of polynomials (see Grade VIII program, Section D-2)
2. Factoring of polynomials:
 - a) common factor
 - b) difference of squares
 - c) trinomials that are perfect squares
 - d) trinomials that are the products of binomials
3. Division of polynomials, extension of rational expressions
4. Addition, subtraction, multiplication and division of rational expressions
5. An awareness of absolute value of an expression
6. Solution of problems involving linear conditions.

C. Extension of Geometry

1. (See Grade VIII program, Section D-3)

D. Variation

1. A study of direct and inverse variation
2. The expression of linear and parabolic expressions in graphic form
3. Common formulae in applied business and science
4. The solution of problems involving applications of variation and formulae.

RECOMMENDED TEXTS

Recommended texts include the following:

- Grade VII: Hanwell et al. CONTEMPORARY MATHEMATICS 1
Keedy et al. EXPLORING MODERN MATHEMATICS, Book 1
Van Engen et al. MATHEMATICS CONCEPTS AND APPLICATION, First Course
- Grade VIII: Hanwell et al. CONTEMPORARY MATHEMATICS 2
Keedy et al. EXPLORING MODERN MATHEMATICS, Book 2
Van Engen et al. MATHEMATICS CONCEPTS AND APPLICATION, Second Course
- Grade IX: Hanwell et al. CONTEMPORARY MATHEMATICS 3
Keedy et al. EXPLORING MODERN MATHEMATICS, Book 3
Devlin et al. ELEMENTARY ALGEBRA
Armour, GEOMETRY SUPPLEMENT

Notes to teachers using the different recommended texts

The comments on the succeeding pages are designed to assist teachers in planning their programs from the various recommended texts. It must be emphasized that these notes are in no way prescriptive. They represent the collective opinion of competent junior high school mathematics teachers who have had experience using the recommended texts.

NOTES TO TEACHERS

CONTEMPORARY MATHEMATICS Series

The CONTEMPORARY MATHEMATICS series has a Teacher's Edition for each grade level. The teachers using CONTEMPORARY MATHEMATICS should note that, due to the order in which concepts are presented, they will have to adapt the course of studies to this series. Furthermore, if time permits at any grade level, it is suggested that more emphasis be placed on solving compound conditions in one variable and simple conditions in two variables.

Grade VII

The changes necessary in Grade VII involve leaving most of the set theory until Grade VIII covering metric geometry more intensely in Grade VII. This section of geometry which includes measures of angles, calculation of perimeters, areas and volumes, and classifications of polygons is a necessary prerequisite for the geometry contained in the Grade VIII book.

Grade VIII

Leaving set theory until Grade VIII necessitates stress being placed on it at that time. Unit IX in Grade VIII should be covered almost entirely during the Grade VIII year because geometry is not contained in the Grade IX book. Fractional numbers and integers should be given very complete coverage in Grade VIII as rational numbers are not introduced until the Grade IX book. It may be wise, however, to give students some indication that fractional numbers may also be negative. Two topics not contained in the Grade VIII book are real numbers and polynomials. These topics are given adequate coverage in the Grade IX text.

Grade IX

In Grade IX rational numbers, real numbers and polynomials are introduced and given adequate coverage. Geometry should have already been covered in Grade VIII. By the end of the year all topics in the course of studies for Grades VII, VIII and IX should be covered. This means that teachers will find it necessary to use their own resources to present the concepts of direct and inverse variation and drawing line graphs and parabolas.

EXPLORING MODERN MATHEMATICS Series

The EXPLORING MODERN MATHEMATICS series has available at each grade level a student's text and a teacher's edition. Programmed supplements are available for Grades VII and VIII.

The series has throughout the texts sets of discovery exercises which are intended to help the students discover the underlying mathematical concepts presented. However, these exercises, due to their complexity, are generally only suited to the superior mathematics students.

Throughout the series rigorous proofs are found. These proofs may be a challenge to the superior students, but due to their high level of difficulty may not be considered appropriate for average and below average students.

Throughout the discussion below, it is occasionally indicated that the presentation of a required concept is considered to be too difficult in EXPLORING MODERN MATHEMATICS. It is expected that the teacher will use whatever other resources may be available to him, such as the other two recommended series.

Grade VII

1. Sets: EXPLORING MODERN MATHEMATICS does not present enough material to coordinate the whole concept of sets and their relationships under various situations. Concepts related to sets not presented in EXPLORING MODERN MATHEMATICS, for example are:
 - a) that the empty set is a subset of all sets
 - b) finite and infinite sets
 - c) identical sets
2. Whole Number System: All concepts are well covered. There are plenty of "Let's Explore" exercises to enable students to study the concepts presented.
3. Factors and Multiples: This chapter has presented some difficulty for average and below average students. For this reason a review of basic material without direct reference to the text should serve as an introduction to this chapter.
4. Rates, Ratio and Percent: Students who used SEEING THROUGH ARITHMETIC have been very well trained in the use of ratio in solving percentage problems. EXPLORING MODERN MATHEMATICS reverts to the conventional method, often resulting in some confusion.
5. Fractional Numbers: The method used in the Operation of Fractions is different from the method in Grades V and VI in the SEEING THROUGH ARITHMETIC texts. Therefore, it might be desirable for teachers to review these operations without particular reference to EXPLORING MODERN MATHEMATICS. EXPLORING MODERN MATHEMATICS presents a study of properties using fractions very well.

6. Geometry: The geometry concepts are well correlated with the program of studies.

Grade VIII

1. Rational Numbers: EXPLORING MODERN MATHEMATICS explores this topic from a very sophisticated point of view with text material requiring a reading level often higher than that of the average Grade VIII student. The book moves quickly into difficult operations with integers and makes no use of the concept of directed numbers. The "Let's Explore" exercises tend to be rather obvious and bright students may become bored with them; or they tend to be too difficult so that most students do not develop the concepts intended. Otherwise, the section on rational numbers is good, but may need supplementary material.
2. Conditions or Equations: Solving equations and drawing graphs of their solutions is well presented, but the classroom teachers should provide additional problems.
3. Geometry: Topics 1, 2 and 3 in the course outline are dealt with in depth in EXPLORING MODERN MATHEMATICS, Book I, and only passing comments are made in Book 2. The triangle, including classifications, perimeters and the sum of the angles, is also found in Book 1. Areas of triangles, quadrilaterals, and circles are developed using the concept of sweeps. Alternate methods of finding area formulas should be explored.
4. Choice Section: one of the following topics is required
 - a) Real numbers are not dealt with at all in Book 2 but are covered in Book 3.
 - b) Polynomials in one variable appear to be adequately treated in Book 2.
 - c) Extension of Geometry The only topic in this section that Book 2 treats is the Pythagorean Theorem, the general proof of which is presented at a very sophisticated level and is difficult to understand.

NOTE: Polynomials in one variable is recommended for teachers using E.M.M.

Grade IX

1. Real Numbers: Section D of the Grade VIII program of studies is not covered completely in EXPLORING MODERN MATHEMATICS Book 3. Order, completeness and density are not dealt with. Properties of real numbers are listed but very little is done to stress these because of their similarity to the properties of rational numbers. Considerable practice is given in working with real numbers in solving and graphing equations but little work in problem solving using real numbers is presented.

2. Extension of Polynomials: With the exception of absolute value, these topics are adequately dealt with. Here the two "cases" are not clearly distinguished, nor is the fact that the absolute sign indicates an operation stressed. It is assumed that the student has experience with polynomials in one variable.
3. Geometry: All nine topics mentioned in Section C of the Grade VIII program of studies are adequately dealt with in EXPLORING MODERN MATHEMATICS Book 3. Note, however, that Section D, Extension of Geometry in Grade VIII, has limited development.
4. Variation: The topic of variation is dealt with as an example of mathematical relationship that can be applied to many physical situations. Similar triangles are used to prove that the graph of an equation of direct variation, $y=kx$, is a set of points that lies on a line containing the origin. The graph of an equation, $y=kx+b$, is shown as a line parallel to the graph $y=kx$. The graph of a parabola is dealt with very briefly.

MATHEMATICS CONCEPTS AND APPLICATIONS, FIRST AND SECOND COURSE AND ELEMENTARY ALGEBRA WITH GEOMETRY SUPPLEMENT

Several kinds of ancillary materials are available to teachers using the texts MATHEMATICS CONCEPTS AND APPLICATIONS, FIRST AND SECOND COURSE. Such materials include:

Teacher's Edition
Practice Tablet
Teacher's Practice Tablet
Tests (on spirit duplicating masters)
Answer Books

Teachers using only the Grade VII or Grade VIII texts should be aware of the course of studies for both grades. Some topics listed in the program of studies as part of the Grade VIII program are introduced in the Grade VII book, particularly some sections on geometry. These topics are best treated during the Grade VII year.

The sequence of topics in either the course of studies or in the textbooks need not be the sequence used by teachers during the school year. In addition, all topics in the chapters listed below need not be included in the program for any given class. Teachers using either of the texts chapter by chapter and page by page will find the program to be much too long and much too difficult for many students. Selection of content and exercise from the text is necessary.

Grade VII

Looking Back sections in this text give an excellent review of the past year's work. These sections are found at the back of the text and the extent of their use will depend on the needs of the class. These needs can be diagnosed by the "Beginning of the Book" tests.

1. Sets: Adequate coverage in Chapter 5.
2. Whole Number System: Well covered in Chapter 5 with the exception of properties which should be supplemented with additional examples.
3. Factors and multiples: Good coverage in Chapter 6.
4. Fractional numbers: Good coverage in Chapters 4, 10, 11 and 12.
5. Rates, ratios and percent: Well covered in Chapters 7 and 14.
6. Geometry: Covered in Chapters 3 and 8. NOTE: Though use of the protractor is included in the Grade VIII program of studies, it is suggested that the topic be taught here.

7. Problem Solving: Chapters 7 and 13 cover general problem solving. Problem solving, however, is also included in other chapters.

Grade VIII

Again there is an excellent review of the Grade VII material which appears at the end of the text in the "Looking Back" section. The amount of this material that should be covered can be determined by the "Beginning of the Book" tests.

1. Rational Numbers:
 - a) Integers--well covered in Chapter 5. Teachers may want to refer back to Chapter 21 in the Grade VII text for information.
 - b) Rational numbers--well covered in Chapter 6.
 - c) Exponents--well covered in Chapter 7.
2. Conditions and Equations: Introduced in Chapters 5 and 6. A teacher will have to supplement this with extra material as the introduction is much too rapid for most students.
3. Geometry: Found in Chapters 4 and 10. Some topics are missing in the text and should be supplemented by other material. Topics not covered here:
 - a) Intersection of coplanar lines (parallel lines)
 - b) Certain construction problems such as bisection of angles, construction of perpendiculars, and construction of parallel lines. Comparison of metric and British systems of measurement are found in Chapter 9.
4. One of the three topics listed in the program of studies is required. Both of these topics are adequately covered in the text:
 - a) Real numbers (Chapter 8)
 - b) Extension of geometry (Chapter 14 with parts of 10)

Grade IX

ELEMENTARY ALGEBRA AND GEOMETRY SUPPLEMENT

Chapter 3 of ELEMENTARY ALGEBRA may be considered as useful review.

1. Real Numbers: Covered in Chapters 2, 13, 14, and 16. The order of the topics appears reasonable. Teachers should use their own discretion on the depth to which the topics are dealt.
2. Extension of Polynomials: Chapters 6, 7, 8, and 5-section 31
Equations - Chapter 4
3. Extension of Geometry: Use the Geometry Supplement. Math labs are intended as optional.

4. Variation: Chapter 11. Treatment is extensive, teachers should be selective in depth of treatment of topics.

Teachers will have to determine which topics of section D of Grade VIII course of studies were covered in Grade VIII. The remaining two topics are then a required portion of the Grade IX program.

RE: GEOMETRY SECTION AND GEOMETRY SUPPLEMENT

Although all geometric concepts of the junior high school program are dealt with to some degree in MATHEMATICS CONCEPTS AND APPLICATIONS, FIRST AND SECOND COURSE, the GEOMETRY SUPPLEMENT provides a concise and adequate coverage of topics for those systems who have left a geometry section for Grade IX. The supplement may also be useful for geometric concepts dealt with in Grades VII and VIII.

The provision of math labs for each unit, or chapter, allows for some diversity of approach in the learning environment, provides for greater understanding of basic concepts and relates mathematics through artistic involvement. Note: The math labs are optional.

Application problems sections are included for appropriate sections with an answer key available.

The following is a brief outline of the GEOMETRY SUPPLEMENT:

Chapter I - Constructions

1. Line segments, angles, perpendicular bisectors, bisection of angles, perpendicularly.
2. Math labs include activities on the Golden Rectangle, curves, symmetry, inscribing polygons, geometric designs, curve sketching.

Chapter II - Pythagorean Theorem

1. A detailed development of the theorem is provided with a major section devoted to applications of the theorem.

Chapter III - Congruent and Similar Triangles

1. Adequately covered with sufficient exercises.

Chapter IV - Measurement

1. Classification of polygons, triangles, quadrilaterals. Labs and exercises provided.

2. Review of perimeter and area of regular polygons. Sufficient exercises included.
3. Circumference and area of the circle.
4. Solids - polyhedron - prisms - cylinders - cones - pyramids - spheres, extensive development of area and volumes.

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